

AD-A060 182

NAVY UNDERWATER SOUND LAB NEW LONDON CONN

F/6 17/1

TRANSFER FUNCTION, IMPULSE RESPONSE AND RERADIATED WAVEFORM FOR--ETC(U)

MAR 67 D A STREMSKY

UNCLASSIFIED

USL-TM-2242-111-67

NL

| OF |

AD
A060 182



END

DATE

FILMED

-12-78

DDC

NW
Good

Copy # 37

MOST Project -3

① NW

001758

AD A060182

LEVEL

USL Technical Memorandum No.

⑭ 456-TM-2242-111-67

⑥
TRANSFER FUNCTION, IMPULSE RESPONSE AND
RERADIATED WAVEFORM FOR AN ELLIPTICALLY SYMMETRIC
RERADIATION FUNCTION IN THE FORM OF A LAGUERRE POLYNOMIAL
(USL PROGRAM NO. 0838)

⑮
F10103

⑰ SF 101 03 16-11224

⑪ 20 March 1967

by

⑩ Donald A. Stremsky

DDC
RECEIVED
OCT 23 1976

This document has been approved
for public release and sale; its
distribution is unlimited.

254 200

2242-111-67

DDC FILE COPY

001758

942-13

U. S. NAVY UNDERWATER SOUND LABORATORY
FORT TRUMBULL, NEW LONDON, CONNECTICUT

TRANSFER FUNCTION, IMPULSE RESPONSE AND
RERADIATED WAVEFORM FOR AN ELLIPTICALLY SYMMETRIC
RERADIATION FUNCTION IN THE FORM OF A LAGUERRE POLYNOMIAL
(USL PROGRAM NO. 0838)

by

Donald A. Stremsky

USL Technical Memorandum No. 2242-111-67

20 March 1967

INTRODUCTION

A computational program has been prepared by the Information Processing Division to compute a particular Reradiation Function $w(x)$, Transfer Function $W(w, P)$, Impulse Response $w(t, P)$, and Reradiated Waveform $g(t, P)$ as defined below in terms of the incident plane wave pulse. This IBM 704 Program designated USL Program No. 0838, is in Fortran II language and is described in Appendixes A and B. Similar computational programs are described in USL Technical Memorandum No. 2242-156-67 and 2242-157-67.

THEORY

Reference (a) contains a description of the mathematical model constructed and the theory behind considering reflection as a re-radiation phenomenon.

This program computes for integer values of D

(a) $a_1 a_2 w(x)$

(b) $W(w, P)$

| | |
|---------------------------------|---|
| ACCESSION for | |
| NTIS | White Section <input checked="" type="checkbox"/> |
| DDC | Buff Section <input type="checkbox"/> |
| UNANNOUNCED | <input type="checkbox"/> |
| JUSTIFICATION | <input type="checkbox"/> |
| BY <i>on file</i> | |
| DISTRIBUTION/AVAILABILITY CODES | |
| A | |

$$(c) \quad kw(t, P)$$

$$(d) \quad kg(t, P)$$

where

$$(1) \quad w(x) = \frac{(-1)^n 2\pi}{a_1 a_2}$$

$$(2) \quad w(w, P) = e^{-1/2(kw)^2} L_n[(kw)^2]$$

$$k = 1/2 [(a_1 p_1)^2 + (a_2 p_2)^2]^{1/2}$$

$$L_n(x) = \frac{e^x}{n!} \frac{d^n}{dx^n} (e^{-x} x^n)$$

= Laguerre polynomial

$$(3) \quad w(t, P) = \frac{1}{n! k \sqrt{2\pi}} e^{-1/2(t/k)^2} \{He_n(|t/k|)\}^2$$

$$He_n(x) = (-1)^n e^{1/2 x^2} \frac{d^n}{dx^n} (e^{-1/2 x^2})$$

= Hermite polynomial

$$(4) \quad g(t, P) = \int_{-\infty}^{+\infty} f(\tau) w(t-\tau, P) d\tau$$

$$f(t) = \begin{cases} A(t) \cos((\omega_0 + \frac{\Delta\omega}{2})(t/\tau)) t + d \\ A(t) = 0 \text{ for } |t| > T \end{cases}$$

COMPUTER PROGRAM DESCRIPTION

A nomenclature listing for USL Program No. 0838 is Appendix A, the flow chart is Appendix B, and the IBM 704 Fortran II Program is Appendix C.

The basic input data deck required by the program consists of four cards.

Table 1

| Card No. | Cols. | Contents |
|----------|--|---|
| 1 | 1-8 9-16 17-24 25-32 33-40 41-48 49-51 52-54 | a_1 a_2 x_1 x_2 c v j |
| | 55-57 | ISKP (set equal to zero to compute Reradiation Function) |
| | 58-60 | JSKP (set to zero to compute Transfer Function) |
| | | KSKP (set equal to zero to compute Impulse Response & Reradiated Waveform) |
| | | For long jobs requiring the use of a dump tape at least one of the above option variables should not be set equal to zero. |
| 2 | 1-8 9-16 17-24 25-32 35-36 39-46 | Initial value of ω Maximum value for ω Initial value of t Initial value of k KK (if set equal to zero, initial value of k will be computed) Maximum value of k |
| 3 | 1-8 9-16 17-24 25-32 33-40 41-48 49-56 57-64 65-72 | λ_1 λ_2 N_1 N_2 Δx_1 Δx_2 Δt Increment of ω Δk |
| | | Components of λ |
| | | Components of N |

Table 1 (cont'd)

| Card No. | Cols. | Contents |
|----------|-------|---|
| 4 | 1-3 | Number of values of Reradiation Function to compute |
| | 4-11 | $\Delta \tau$ |
| | 12-19 | Maximum value for t |
| | 20-27 | ω_0 |
| | 28-35 | $\Delta \omega$ |
| | 36-43 | Maximum value of τ |
| | 44-51 | Initial value of τ |
| | 52-59 | θ |

FORMATS

- Card No. 1 - Format 6F8.3, 4I3
- 2 - Format 4F8.3, 2X, I2, 2X, F8.3
- 3 - Format 9F8.3
- 4 - Format I3, 7F8.3

Tape Units Required

| Tape Unit No. | Tape Identification |
|---------------|--|
| 3 | Data input |
| 4 | Values for Reradiation Function, Transfer Function, and Impulse Response |
| 5 | Calcomp Plotter containing values for Reradiation Function |
| 6 | Reradiated waveform array (k,t) |
| 7 | Transfer Function Array (k,w) |

Tape Units Required (cont'd)

| Tape Unit No. | Tape Identification |
|----------------------------------|------------------------------|
| 8 | Impulse Response Array (k,t) |
| 0 | |
| { SS-5 must be down to dump | Dump Tape |
| No other sense switches are used | |

Subroutine Amp required - computes values of A array referred to under equation 4.

PROGRAM OUTPUT

Tape #4 contains:

(1) The values for the \bar{z} array plus the corresponding values for the Reradiation Function according to Format (1X, F10.5, 5X, F10.5)

(2) The values for the product of k and w plus the corresponding values of the Transfer Function according to Format (1X, F10.5, 5X, F10.5)

(3) The values for t/k plus the corresponding values for the Impulse Response according to Format (1X, F10.5, 5X, F10.5)

Tape #5 contains:

The values for the Reradiation Function (Calcomp Plotter tape)

Tape #6 contains:

The Reradiated Waveform Array (k,t) according to Format (F10.5)

Tape #7 contains:

The Transfer Function Array (k,w) with Format (F10.5)

Tape #8 contains:

The Impulse Response Array according to Format (F10.5)

USL Tech. Memo.
2242-111-67

Tape #0 is a dump tape.

Notes: This program contains options to compute or not to compute any of the functions mentioned above. Tapes Unit Nos. 6, 7, and 8 can be used as input to USL Program No. 0809, "Representation of Surfaces: A Computer Program to Plot Contours and Draw Perspective Views", by Edward Beardsworth, Jr.

SUMMARY

An IBM 704 Fortran program, USL Program No. 0838, has been written to compute a particular Reradiation Function, Transfer Function, Impulse Response, and Reradiated Waveform in terms of the incident plane wave pulse.

D. A. Stremsky
D. A. STREMSKY
Mathematician

USL Tech. Memo.
2242-111-67

LIST OF REFERENCES

- (a) Edward S. Eby, "Spectra and Waveforms of Bottom Reflected Pulses",
USL Tech. Memo. No. 914-160-66 of 10 June 1966.

APPENDIX A

NOMENCLATURE LISTING FOR USL PROGRAM NO. 0838

| | |
|--------------|---|
| S(I) | $\left(\frac{x_1}{a_1}\right)^2 + \left(\frac{x_2}{a_2}\right)^2$ |
| Z(I) | \sqrt{SCL} |
| RERAD (I) | Element of Reradiation Function Array |
| TRFER (I) | Element of Transfer Function Array |
| AKW (LM,I) | k.w |
| RESP (LM,I) | Element of Impulse Response Array |
| RATIO (LM,I) | t/k |
| GSUM (LM,J) | Element of Reradiated Waveform Array |
| A1 | a_1 |
| A2 | a_2 |
| X1 | x_1 |
| X2 | x_2 |
| C | c |
| V | v |
| N | η |
| W | w |
| WMAX | Maximum value for w |
| T | Initial value for t |
| AK | k |
| AKMAX | Maximum value for k |

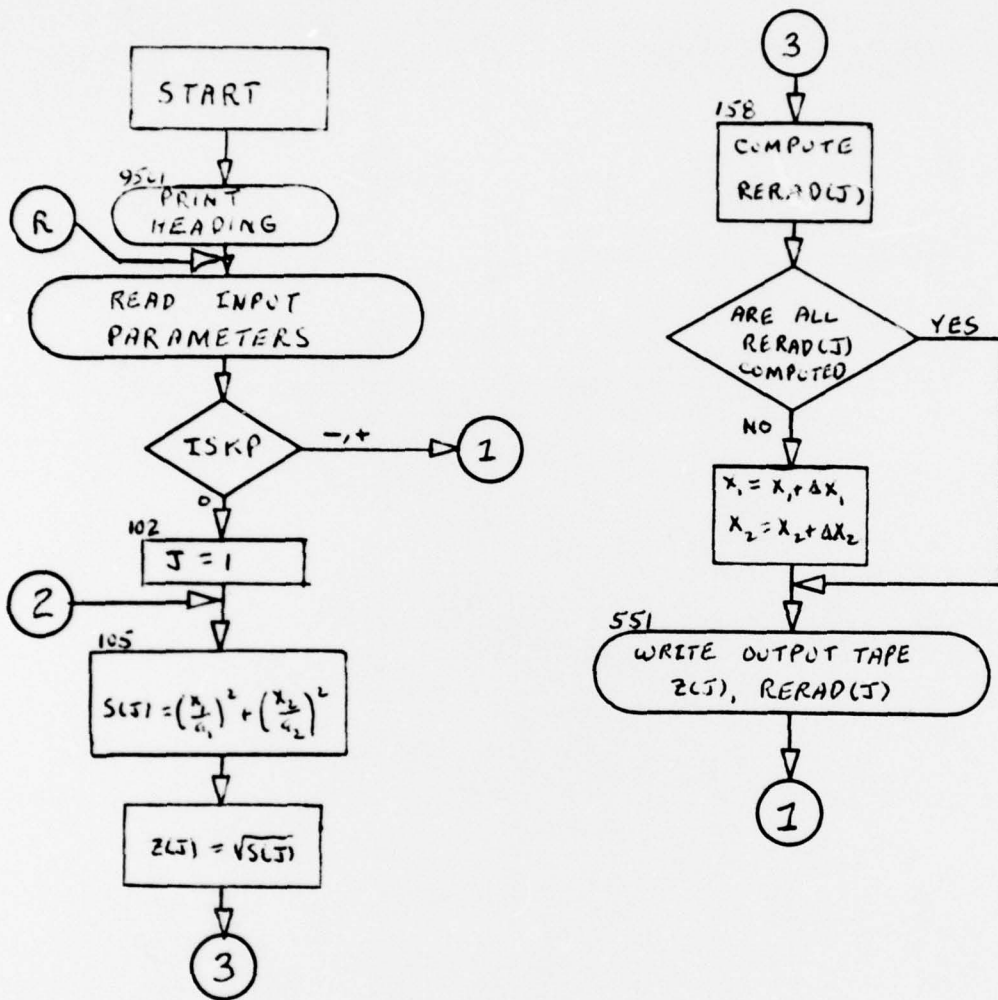
| | | |
|-------|--|---------------------------|
| B1 | λ_1 | } components of λ |
| B2 | λ_2 | |
| B3 | N_1 | } components of N |
| B4 | N_2 | |
| B5 | Δx_1 | |
| B6 | Δx_2 | |
| B7 | Δt | |
| B8 | Increment of w | |
| B10 | $\Delta \tau$ | |
| B12 | Δk | |
| Omega | ω_0 | |
| DELTA | Δw | |
| TT | Maximum value for τ | |
| TAV | Initial value of τ | |
| PHI | ϕ | |
| N1 | Number of values of Reradiation Function to compute | |
| TMAX | Maximum value for T | |

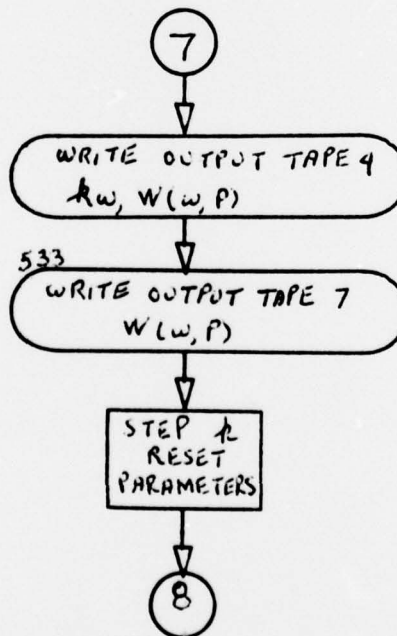
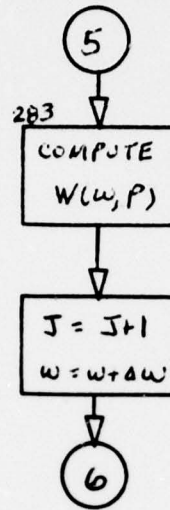
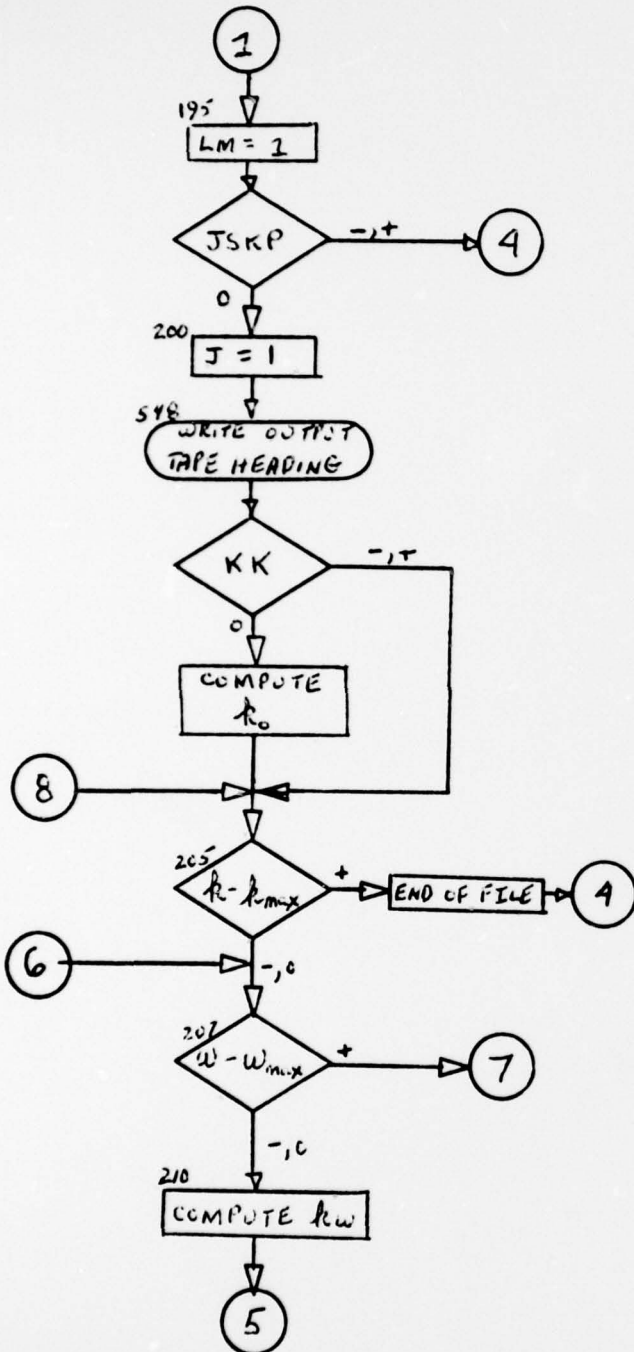
USL Tech. Memo.
2242-111-67

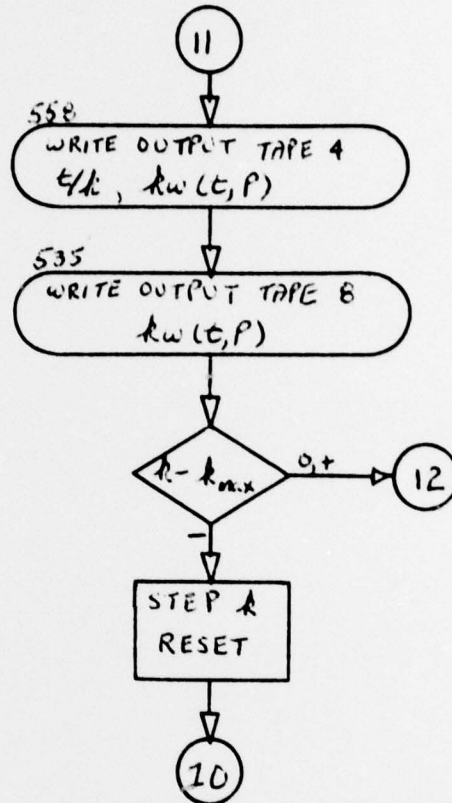
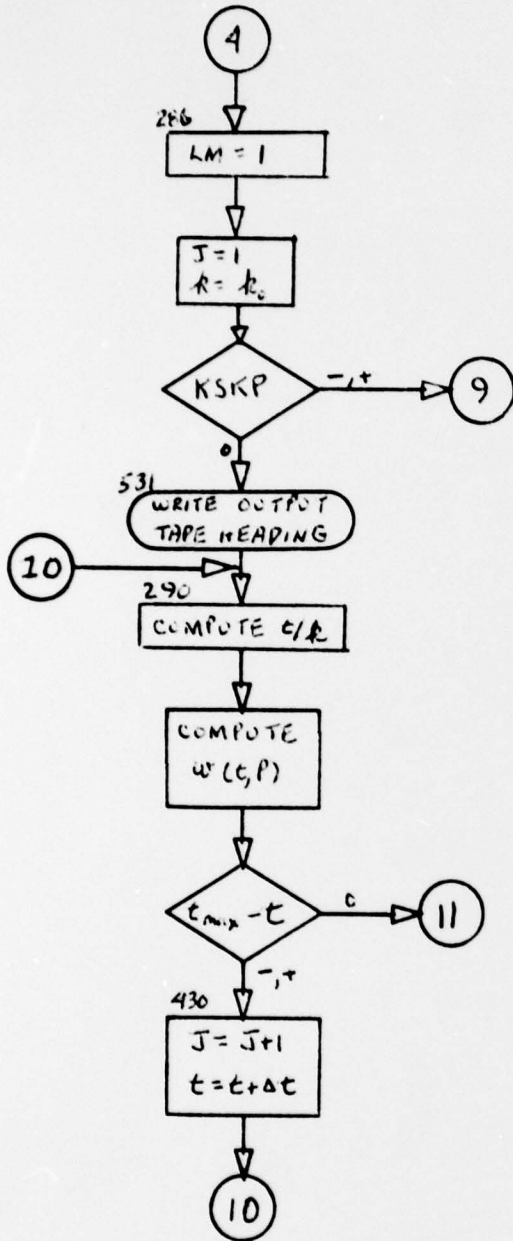
APPENDIX B

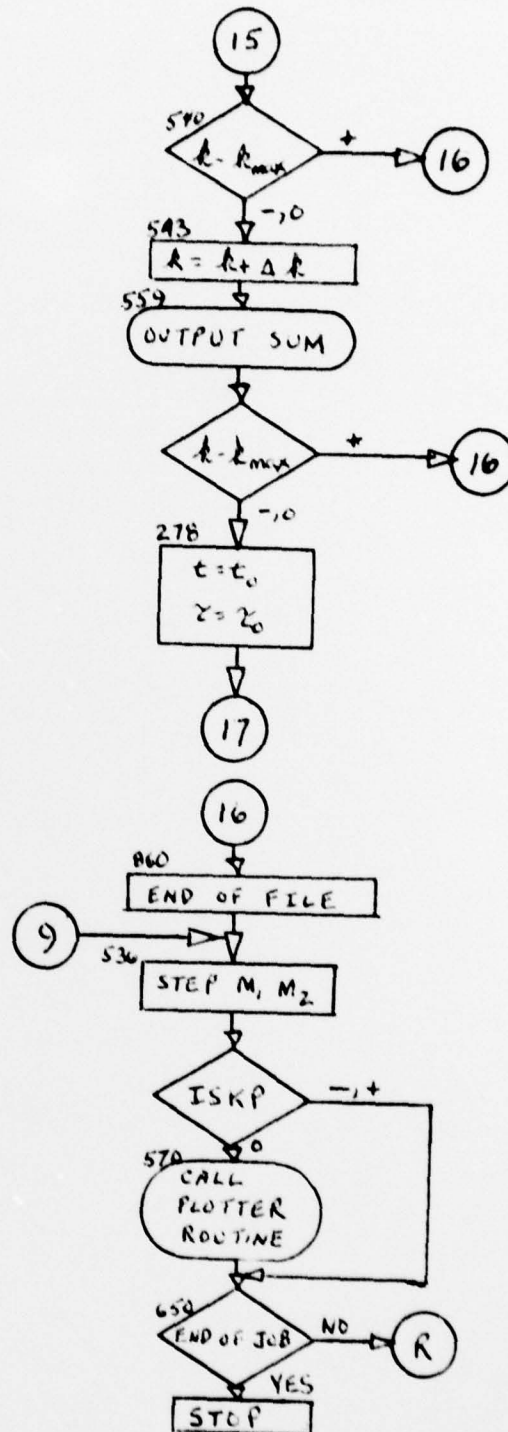
FLOW CHART FOR USL PROGRAM NO. 0838

"RERADIATION FUNCTION, TRANSFER FUNCTION, IMPULSE RESPONSE (CASE 2)"









USL Tech. Memo.
2242-111-67

APPENDIX C

FORTRAN PROGRAM NO. 0838

```

C      RERADIATION FUNCTION, TRANSFER FUNCTION, IMPULSE RESPONSE (CASE 2)
C      D. A. STREMSKY
      DIMENSION Z(500), RERAD(500), TRFER(50,50), AKW(50,50), RATIO(50,50), R
      IESP(50,50), SUM(50), HSUM(50), S(500), GSUM(50,50), R(1000), IDUMP(18)
      DIMENSION BUFFER(1024), XAXIS(500), YAXIS(500)
STDJN ALF *0838
STECD ALF *
      WRITE OUTPUT TAPE 4,9501
9501  FORMAT(1H1)
      READ INPUT TAPE 3,9502,DI
9502  FORMAT(A5)
      IF (TDJN-DI)9503,9504,9503
9503  PAUSE 6
9504  WRITE OUTPUT TAPE 4,9502,DI
      WRITE OUTPUT TAPE 4,9505
9505  FORMAT(10X32HD,A,STREMSKY,ROOM 3126, CODE 2242)
      READ INPUT TAPE 3,100,A1,A2,X1,X2,C,V,N,ISKP,JSKP,KSKP
100   FORMAT(6F8.3,4I3)
      READ INPUT TAPE 3,101,W,WMAX,T,AK,KK,AKMAX
101   FORMAT(4F8.3,2X,12,2X,F8.3)
      READ INPUT TAPE 3,103,B1,B2,B3,B4,B5,B6,B7,B8,B12
103   FORMAT(9F8.3)
      READ INPUT TAPE 3,104,N1,B10,TMAX,AMEGA,DELTA,TT,TAU,PHI
104   FORMAT(I3,7F8.3)
      W1=W
      AK1=AK
      T1=T
      TAU1=TAU
      PIE=3.1415
      PCP=2.5066
      DEG=180./PIE
      NP1=N+1
      NP2=N+2
      SUM(1)=0.
      SUM(2)=1.
      IF (ISKP)195,102,195
102   J=1
105   S(J)=(X1/A1)**2+(X2/A2)**2
      ZX=S(J)
      Z(J)=SQRT(ZX)
      IF (N)156,156,157
156   SIGN=1.
      GO TO 158
157   SIGN=(-1)**N
158   RERAD(J)=SIGN*2.0*PIE*A1*A2
      IF (N1-J)546,546,175
175   J=J+1
      X1=X1+P5
      X2=X2+P6
      GO TO 105
546   WRITE OUTPUT TAPE 4,551
551   FORMAT(1X36HZ, RERADIATION FUNCTION)
      WRITE OUTPUT TAPE 4,552,(Z(I),RERAD(I),I=1,N1)
552   FORMAT(1X,F10.5,5X,F10.5)
      WRITE OUTPUT TAPE 4,553
553   FORMAT(///)
195   LN=1

```

```

      IF (JSKIP) 286, 200, 266
200  J=1
548  WRITE OUTPUT TAPE 4, 554
554  FORMAT (1X34HKW
      IF (KK) 205, 202, 205
      TRANSFER FUNCTION)
202  P1=B1-C*B3/V
      P2=B2-C*B4/V
      CR=(A1*P1)**2+(A2*P2)**2
      AK=SQRT(CR)/C
205  IF (AK-AKMAX) 207, 207, 285
207  IF (W-WMAX) 210, 210, 250
210  AKW(LM, J)=AK*W
      R2=AKW(LM, J)**2
      R3=-R2/2.
      CCEF1=EXP(R3)
      IF (N) 230, 230, 215
215  DO 225 I=3, NP2
      AIM3=I-3
      IM1=I-1
      IM2=I-2
      PAR=2.*AIM3+1.-R2
      PART=AIM3**2
      SUM(I)=-PAR*SUM(IM1)-PART*SUM(IM2)
225  CONTINUE
230  NPRCD=1
      IF (N) 280, 280, 260
260  DO 275 L=1, N
      NEWL=L
      NPRCD=NPRCD*NEWL
275  CONTINUE
280  PRCD=NPRCD
      IF (N) 281, 281, 282
281  SIGN=1.
      GO TO 283
282  SIGN=(-1)**N
283  TRFER(LM, J)=CCEF1*SUM(NP2)*SIGN/PROD
      J=J+1
      W=W+BR
      GO TO 207
250  N2=J-1
      N4=LM
      WRITE OUTPUT TAPE 4, 555, ((AKW(LM, I), TRFER(LM, I), I=1, N2), LM=N4, N4)
555  FORMAT (1X, F10.5, 5X, F10.5)
533  WRITE OUTPUT TAPE 7, 515, ((TRFER(LM, I), I=1, N2), LM=N4, N4)
515  FORMAT (F10.5)
      J=1
      W=W1
      LM=LM+1
      AK=AK+R12
      GO TO 205
285  END FILE 7
      END FILE 7
286  LM=1
      J=1
      AK=AK1
      IF (KSKIP) 536, 531, 536
531  WRITE OUTPUT TAPE 4, 557
557  FORMAT (1X34HT/K
      IMPULSE RESPONSE)

```

```

290 RATIO(LM,J)=T/AK
   G2=RATIO(LM,J)**2
   G3=-G2/2.
   IF (J$KPI) 291,297,291
291 NPRCD=1.
   IF (N) 296,296,292
292 DO 295 L=1,N
   NEWL=L
   NPRCD=NPRCD*NEWL
295 CONTINUE
296 PRCD=APROD
297 DEN=PROD*PCP
   G4=EXP(G3)
   CCEF2=G4/DEN
   G5=RATIO(LM,J)
   IF (G5) 300,320,320
300 G6=-G5
   GO TO 350
320 G6=G5
350 HSUM(1)=0.
   HSUM(2)=1.
   IF (N) 410,410,360
360 DO 400 K=3,NP2
   AKM3=K-3
   KM1=K-1
   KM2=K-2
   HSUM(K)=G6*HSUM(KM1)+AKM3*HSUM(KM2)
400 CONTINUE
410 G7=HSUM(NP2)
   G8=G7**2
425 RESP(LM,J)=CCEF2*GA
   IF (TMAX-T) 500,430,430
430 J=J+1
   T=T+B7
   GO TO 290
500 N3=J-1
   N4=LM
   WRITE OUTPUT TAPE 4,55R,((RATIO(LM,I),RESP(LM,I),I=1,N3),LM=N4,N4)
558 FORMAT(1X,F10.5,5X,F10.5)
535 WRITE OUTPUT TAPE 8,516,((RESP(LM,I),I=1,N3),LM=N4,N4)
516 FORMAT(F10.5)
   IF (AK=AKMAX) 495,237,237
495 AK=AK+R12
   LM=LM+1
   J=1
   T=T1
   GO TO 290
237 LM=1
   END FILE 8
   END FILE 8
   N5=0
   AK=AK1
   I=1
502 D11=R7/AK
   T=T1
   J=1
   D12=AR5F(D11)
503 GSUM(LM,J)=0.

```

```

505 FRACT=TAU/TT
    F1=AMEGA*DELTA*FRACT/2.0
    E2=F1*TAU
    E3=E2*PHI
    E4=CCSF(E3/DEG)
    CALL AMP(TAU,R)
    FCN=R(I)*E4
    TDIF=(T-TAU)/AK
    GRAPE=ABSF(TDIF)
    PLUM=GRAPE-1.0
    IF(PLUM)850,850,279
279 E9=0.0
    GO TO 801
850 E5=GRAPE/D12
    NE5=E5
    IA=NE5+1
    IB=NE5+2
    E6=GRAPE-RATIO(LM,IA)
    E7=E6/D11
    E8=1.0-E7
    RSPN=E7*RESP(LM,IB)+E8*RESP(LM,IA)
    E9=FCN*RSPN*B10
801 GSUM(LM,J)=GSUM(LM,J)+E9
    TAU=TAU+B10
    I=I+1
    E10=ARSF(TAU)
    IF(TT-E10)520,505,505
520 GSUM(LM,J)=GSUM(LM,J)/AK
    IF(TMAX-T)540,540,525
525 T=T+B7
    J=J+1
    TAU=TAU1
    IF(SENSE SWITCH 5)9997,9999
9997 DO 9998 LK=1,15
    IDUMP(LK)=+0
9998 CONTINUE
    IDUMP(16)=-6
    IDUMP(17)=+0
    IDUMP(18)=N5
    CALL DUMP(IDUMP)
9999 GO TO 503
540 IF(AK-AKMAX)543,543,860
543 AK=AK+B12
    N3=J-1
    N4=LM
    WRITE OUTPUT TAPE 6,559,((GSUM(LM,I),I=1,N3),LM=N4,N4)
559 FORMAT(F10.5)
    N5=N5+J
    IF(AK-AKMAX)278,278,860
278 LM=LM+1
    T=T1
    TAU=TAU1
    I=1
    GO TO 502
860 END FILE 6
    END FILE 6
536 M1=N1+1
    M2=N1+2

```

```

      IF (ISKP) 650,570,650
570  CALL PLOTS(BUFFER(1024),1024,5)
      DO 560 J=1,N1
      XAXIS(J)=Z(J)
      YAXIS(J)=RERAD(J)
560  CONTINUE
      CALL PLOT (0.0,5.0,-3)
      CALL SCALE (YAXIS,5.0,N1,1,10.0)
      CALL SCALE (XAXIS,10.0,N1,1,10.0)
      CALL LINE (XAXIS,YAXIS,N1,1,1,1)
      CALL AXIS (0.0,0.0,20HRERADIATION FUNCTION,20,5.0,90.0,YAXIS(M1),Y
1AXIS(M2),10.0)
      CALL AXIS (0.0,0.0,1HZ,-1,10.0,0.0,XAXIS(M1),XAXIS(M2),10.0)
      CALL PLOT (0.0,0.0,999)
650  READ INPUT TAPE 3,9502,ED
      IF (ED=TEOD) 9503,9509,9503
9509 WRITE OUTPUT TAPE 4,9511
9511 FORMAT(4HOEND)
      END FILE 4
9510 STOP 5
      END(1,1,0,1,1)

```